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Evaluation of students' environmental attitude instruments: exploratory and confirmatory factor analysis

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ABSTRACT

One's environmental attitude can predict human behavior toward the environment. This study aimed to validate the environmental attitude instrument with the science, technology, engineering, and mathematics in ethnoscience-integrated (Ethno-STEM) approach. The questionnaire consisted of 16 items and was tested on 159 eighth-grade students. Data were analyzed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The communality value of three instrument items was less than 0.5, so they were excluded in EFA stage 1. The EFA stage 2 test results showed that the 13 instrument items had a factor loading of more than 0.5 and were categorized into five factors. The CFA stage 1 was conducted using linear structural relations (LISREL) and obtained the t-value for all items in factors 1-4 more than the t-table, so they were declared valid. Factor 5 was omitted in CFA test stage 2 due to invalid items. The CFA test results showed that the t-count of the four factors was more than the t-table. Based on the goodness of fit value, the model and measurement matrices were the same (model fit). Thus, the environmental attitude instrument items are declared valid, and the model is fit. The instrument can be used to measure environmental attitudes.

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1. INTRODUCTION

In today's modern world, it is undeniable that science is an essential culture in improving the quality of life. Students' ability to reason scientifically and have a scientific attitude is laid out by science education [1]. Science learning should foster students' insight and perspective that science is a way of life [2]. Scientific attitude has a close relationship with science as a process. Scientific attitudes can be developed through curiosity, honesty, respect for others, open-mindedness, and environmental attitudes.

Over the past several decades, researchers in various fields have attempted to understand environmental attitudes, how these attitudes change between individuals over time, and how these attitudes influence behaviors. Responses to survey questions are frequently used to assess environmental attitudes [3]. Environmental attitudes and behaviors of the younger generation are essential for environmental sustainability [4]. A sustainable future may be realized by changing people's behavior and lifestyle by reducing consumption [5]. Therefore, spreading knowledge through sustainable practices is essential to preserving social, economic, and environmental harmony [6]. Changing human behavior can cultivate a positive attitude toward the environment [7]. Individuals with an excellent environmental attitude are also expected to behave positively towards the environment.

The science, technology, engineering, and mathematics in ethnoscience-integrated (Ethno-STEM) approach is a teaching method that combines science, technology, engineering, and math with the knowledge and skills that are part of the local cultural context, implemented in the real world [8]–[10]. Ethnoscience investigates, studies, and uses people's knowledge of the culture, ethics, morals, noble values, and local wisdom of ethnic's groups, including scientific concepts reconstructed into scientific knowledge. Integrating ethnoscience and STEM-based science learning can be combined with learning needs in the 21st century. The Ethno-STEM approach has a challenge in science learning to bring students closer to issues relevant to their lives [11], [12]. Therefore, the Ethno-STEM approach is expected to overcome energy efficiency, resource depletion, and environmental quality challenges.

The Ethno-STEM approach aids students more effortlessly in comprehending science concepts since the concepts provided integrate local culture around students in the science information taught in schools [12]–[14]. It is possible to integrate scientific concepts into subjects based on indigenous science. STEM methods can be used to integrate the scientific concepts from this reconstruction into scientific education [15]. Integrating local culture into science learning may solve the issues encountered during the process because it will increase students' enthusiasm for the subject and make learning more meaningful.

Previous research on the development of environmental attitude instruments was carried out by Artvinli and Demir [16]. They developed a 3-point Likert scale instrument to measure the environmental attitude of third-grade elementary school students consisting of three sub-factors, namely: i) positive environmental attitude; ii) environmental information and awareness; and iii) negative environmental attitude [16]. Uzun *et al*. [17] developed environmental behaviors which consist of three sub-scales: i) environmental behavior sub scale (EBSS), ii) environmental opinion sub scale (EOSS), and iii) environmental emotions sub scale (EESS) [17]. Orbanic and Covac [18] explored students' environmental attitudes using a five-point Likert scale related to attitudes toward nature and responsibility for environmental issues [18].

Research by Winarni *et al*. [19] on the animal life cycle revealed that by using the project based learning (PjBL) and STEM models, elementary school students' environmental attitudes, knowledge, competence, and scientific literacy significantly improved. Environmental attitudes show a strong relationship with scientific literacy, context components, knowledge, and competence of fourth-grade students regarding the animal life cycle [19]. Orhan [20] revealed that even though high school students have very positive opinions and emotions towards the environment, they do little positive action towards the environment. This result is significant because having positive opinions and emotions toward the environment is not enough to solve today's challenging environmental problems [20].

Previous research on the Ethno-STEM approach revealed that the Ethno-STEM approach improved science process skills [21]. The research results on a project-based integrated learning model with an Ethno-STEM approach concluded that learning with this model positively improved students' learning abilities [4], [10], [11]. Other study findings show that learning natural materials combined with Ethno-STEM can fully develop students' mastery of chemical concepts, preservation of national culture, perseverance, and creative and innovative thinking [22].

Research on masters of chemistry education designed and implemented an integrated Ethno-STEM chemistry learning project on water purification using Moringa (*Maringo oleifera*) seed extract. The findings showed that students can reconstruct ethnic-based scientific knowledge in the context of STEM and water purification experiments with moringa seed extract bio-coagulants [23]. After using the ethno-STEM approach, students' innovative and creative personalities have excellent profiles [13]. STEM activities have developed students' perceptions and attitudes in these areas [24]. Therefore, the Ethno-STEM approach is expected to overcome energy efficiency, resource depletion, and environmental quality challenges. This research is necessary because there is no data on environmental attitudes in Ethno-STEM science learning. As a result, this study aims to evaluate environmental attitudes for expressing students' environmental attitudes in science learning through an Ethno-STEM approach using factor analysis.

2. RESEARCH METHOD

2.1. Research design

This research is instrument development research that, in previous studies, reached the expert validation stage with valid results. The questionnaire instrument's feasibility and relevance were evaluated using rational analysis by competent panels or expert judgment to fulfill the theoretical validity test [25]. Furthermore, in this study, empirical construct validation of environmental attitudes was carried out in science learning with the Ethno-STEM approach using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

2.2. Research instrument

Environmental attitudes are very crucial constructs in environmental psychology [26]. It is a way of thinking and acting that constantly seeks to protect the local natural environment and works to mitigate any damage already done. In this study, the environmental attitude value is measured by students' concern for the environment with indicators adapted from the Environmental Attitudes Inventory (EAI) instrument [26] and the North American Association for Environmental Education [27]. The indicators of environmental attitudes developed include: i) water management; ii) waste management; and iii) individual conservation behavior. Based on this conceptual basis, 16 questionnaire items are produced, as presented in Table 1. Each item has four responses: "strongly agree," "agree," "disagree," and "strongly disagree". The 16 items consist of three factors: i) factor 1 (AIR 1, AIR2, AIR3, and AIR4); ii) factor 2 (LIM1, LIM2, LIM3, LIM4, LIM5, LIM6, LIM7); and iii) factor 3 (KON1, KON2, KON3, KON4, KON5).

Table 1. Questionnaire items

Construct	Item code	Item number	Statement
Water management	AIR1	1	I do not mind if the government regulates the use of water for the batik industry
	AIR2	2	Making batik waste processing installations is the government's or company's obligation. If not available, batik waste can be thrown into the river.
	AIR3	3	I wash the practicum equipment with water as needed.
	AIR4	4	I can wash the practicum equipment with water flowing in rivers or public waterways.
Waste management	LIM1	6	If I were a batik entrepreneur, I would dilute the wastewater before throwing it into the river.
	LIM2	7	I would build my batik waste processing installations if I were a batik entrepreneur.
	LIM3	8	I grow aquatic plants (water hyacinth, *kiambang*, hydrilla) which reduce heavy metal pollution in batik waste.
	LIM4	9	I do not mind if batik producers throw their waste into the river.
	LIM5	10	If I were a batik entrepreneur, I would prefer to make batik printing because it is more economical, and the colors last longer.
	LIM6	11	I use batik patchwork for other purposes, such as crafts.
	LIM7	12	I reuse the rest of the wax for the batik process.
Individual conservation behavior	KON1	5	I think using kerosene stoves to melt night candles should be replaced with electric stoves.
	KON2	13	I prefer natural batik dyes because synthetic dyes contain heavy metals.
	KON3	14	I prefer synthetic batik dyes because they are cheap.
	KON4	15	Colored river water is an indicator that the batik process is economically running.
	KON5	16	In my opinion, batik producers have created rapid economic growth. There is no problem with environmental damage.

2.3. Data collection technique

The questionnaire instrument was validated through a theoretical and empirical validity test. The theoretical validity test was fulfilled from the content validity estimated by testing the feasibility and relevance of the questionnaire instrument through rational analysis by a competent panel or expert judgment [25]. The questionnaire instrument trial respondents were 159 junior high school students. The empirical validation of the instrument was analyzed using EFA with SPSS 25 and CFA using LISREL.

2.4. Data analysis

Using the data, an EFA analysis was carried out on the study participants. This EFA analysis was conducted to determine how item features are arranged under certain factors [28]. The EFA test was carried out to determine the number of dimensions and the grain components of each dimension. The EFA test includes: i) Determinant of the correlation matrix; ii) Correlation matrix; iii) Kaiser-Meyer-Olkin measure of sampling adequacy (KMO); iv) Bartlett test of sphericity; v) Measure of sampling adequacy (MSA)-anti image correlation (AIC); vi) Extracted Communalities; vii) Total variance explained; and viii) Factor loading. It will be eliminated if the item has less than 0.5 of factor loading. The hypothetical model will be validated by CFA using the structural model equation method in the following step. The item's suitability was tested using the CFA test. The model was evaluated using the goodness of fit (GOF) statistical information. The standard regression weight (λ) of 0.5 is removed from the data.

3. RESULTS AND DISCUSSION

3.1. Exploratory factor analysis

One way to summarize relevant variables is through exploratory factor analysis. This method reduces the number of variables by identifying the potential constituents and factors that support the entire set of variables [6]. The initial structure of the 16-item underlying measure of Ethno-STEM environmental attitudes was obtained through the EFA. The factor scale structure was discovered using the principal

component analysis (PCA) and the varimax rotation method. The Bartlett sphericity test and the Kaiser-Mayer-Olkin (KMO) coefficient were used to determine whether the data fit factor analysis. EFA aims to find multiple measurement variables that each factor represents [29]. EFA is carried out in two stages because three items are eliminated in stage 1. The results of the EFA stage 1 are presented in Table 2.

Based on Table 2, it is concluded that items AIR4, LIM1, and KON5 were excluded from the test. This is because the community value for these 3 variables<0.5. Furthermore, the EFA test stage 2 was carried out, as presented in Table 3.

Table 2. Results of EFA test stage 1

No	Test	Criteria	Analysis result	Decision
1	Determinant of correlation matrix	Determinant close to 0	0.053	The correlation matrix between variables is interrelated
2	Correlation matrix	0.3<correlation coefficient value<0.9 (Qualified)	0.3<correlation coefficient value<0.9 (Qualified)	Qualified
3	Kaiser-Meyer-Olkin measure of sampling adequacy	KMO>0.5 (Close to 1)	0.628	The index of the distance comparison between the correlation coefficient and the partial correlation coefficient is fulfilled
4	Bartlett Test of Sphericity	Sig<0.05 (5%)	Sig: 0.000	Fulfilled
5	MSA-Anti Image Correlation (AIC)	AIC>0.5	All AIC for 16 variables> 0.5	Further testing was carried out
6	Extracted communalities	i) 95% confidence level, communality>0.5; ii) Sample size>250 communality value>=0.6; iii) if possible>0.7	Community value for 3 variables<0.5 (AIR4, LIM1, KON5)	The three variables (AIR4, LIM1, KON5) could not explain the factor and were excluded from the calculation.

Table 3. Results of EFA test stage 2

No	Test	Criteria	Analysis	Decision
1	Determinant of correlation matrix	Determinant close to 0	0.111	The correlation matrix between variables is interrelated
2	Correlation Matrix	0.3<Correlation coefficient value <0.9 (Qualified)	0.3<Correlation coefficient value<0.9 (Qualified)	Qualified
3	Kaiser-Meyer-Olkin Measure of sampling adequacy	KMO>0.5 (Close to 1)	0.611	The index of the distance comparison between the correlation coefficient and the partial correlation coefficient is fulfilled
4	Bartlett Test of Sphericity	Sig<0.05 (5%)	Sig: 0.000	Fulfilled
5	MSA-anti image correlation (AIC)	AIC>0.5	All AIC for 16 variables >0.5	Further testing was carried out
6	Extracted communalities	i) 95% confidence level, communality>0.5; ii) Sample size>250 communality value >=0.6; iii) if possible >0.7	Community value for 13 variables >0.5	Further testing was carried out
7	Total variance explained	Total variance explained>60% with Eigenvalues>1	Five factors have eigenvalues >1	Five factors can be arranged in this variable
8	Factor loading	Determination of variables that are included in the factor, the minimum number of factors in one factor is at least three items	Factor 1: KON1, KON2, KON3	Qualified
			Factor 2: AIR1, AIR2, AIR3	Qualified
			Factor 3: LIM5, LIM6, LIM7	Qualified
			Factor 4: LIM2, LIM3	Unqualified, and variables need to be added
			Factor 5: LIM4, KON5	Unqualified, and variables need to be added
9	Component transformation matrix	Each component has a correlation value>0.5	Correlation value for components 1-5>0.5	The five factors formed (Factors 1-5) are correct in summarizing the 13 existing variables

3.2. Confirmatory factor analysis

The criteria to test the validity of the item on the latent variable is to use the t-test [30]. The results of the CFA test stage 1 are presented in Figure 1. In this test, with 159 cases, the degrees of freedom are 159-2=157. The value of the t-table at dk=157 and=0.05 is 1.65. Based on the results of the LISREL analysis in

Figure 1, the t-count value of all items in factors F1, F2, F3, and F4 has a t-count>t-table (1.65) [31]. The F5 factor contains KON4 items with a t-count value (1.64) <t-table (1.65). The instrument items in the F1 to F4 factors are valid, while the F5 factor has one invalid item (KON4). Thus, it is necessary to recalculate after removing invalid items (KON4). Factor F5 was excluded from the CFA test stage 2 because it only consisted of 1 valid item. The results of the CFA test stage 2 are presented Figure 2.

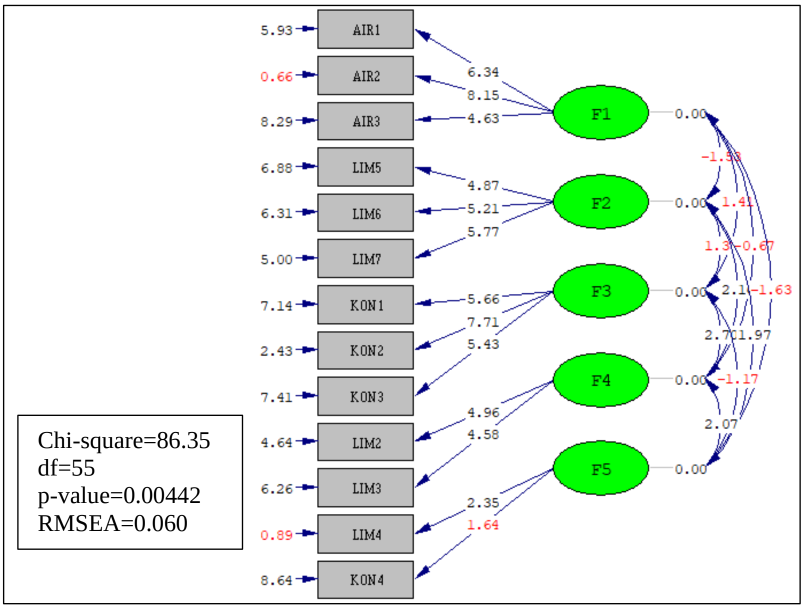

Figure 1. The t-count value of the CFA stage 1 of the environmental attitude instrument

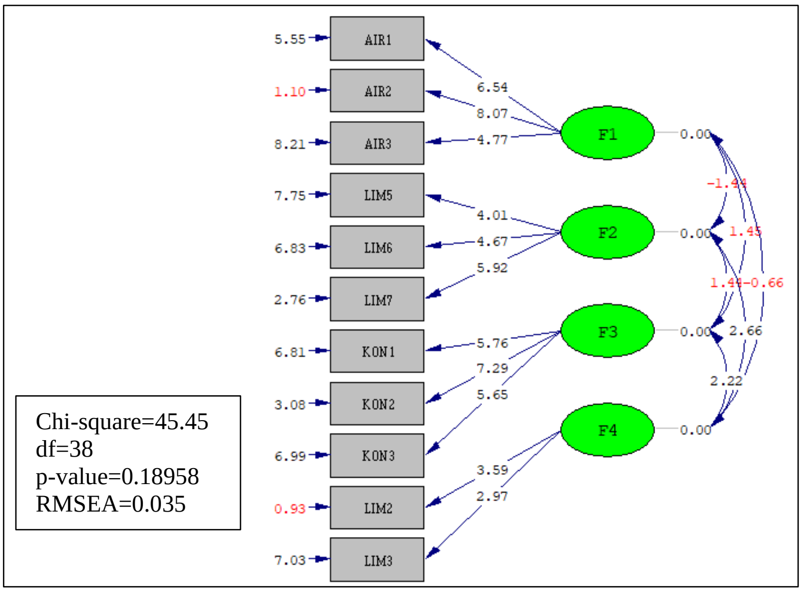

Figure 2. The t-count value of the CFA stage 2 of the environmental attitude instrument

3.3. Discussion

The EFA stage 1 found three items that did not meet the requirements, so they were excluded from the calculation. From EFA stage 2, 13 additional questionnaire items from EFA stage 2 have the required loading factors, so they are not eliminated. Additionally, these items are broken down into five dimensions, Factors 1 to 5. The first dimension consists of three items indicating conservation, the following three concerning water management, and the last three concerning waste management. After the EFA test, the CFA

test was carried out to determine the level of goodness of the data based on the proposed model [17], [32]. The results of LISREL analysis in Figure 1 show the t-count value of all items on factors F1, F2, F3, and F4 has t-count>t table (1.65). It was concluded that the instrument items in the F1 to F4 factors were valid. The F5 factor was eliminated because it had invalid items. Thus, it can be confirmed that the environmental attitude instrument consists of 11 items with four factors: water management (F1), waste management (F2), individual conservation behaviors (F3), and new factors (F4).

Model checks met goodness-of-fit criteria (p-value>0.05), the root mean square error of approximation (RMSEA) 0>0.90, and compliance with requirements was reflected in the CFA results, which showed satisfactory psychometrics characteristics [28], [33]. Construct validity also produced satisfactory results based on factor loading greater than 0.5 for each proportional element. This condition indicated that all statement items of the Environmental Attitude Instrument were significant and could be measured in constructed form. Confidence test results based on Cronbach alpha should also meet the criteria of more than 0.60. Thus, the environmental attitude instrument items are declared valid, and the model is fit. These factors can be used to reveal environmental attitudes [34].

This result is consistent with the previous research on the connection between knowledge constructs and beliefs, practices, and behaviors [35]. The factors crucial for fostering environmental literacy must be considered before developing an efficient environmental education program. Environmental education and psychology have studied environmental knowledge, attitudes, and behavior differently [17]. Since attitude is a construct, it cannot be directly observed. In studies of environmental attitudes, both direct self-report methods (such as questionnaires and interviews) and much less frequently implicit techniques (such as observation, priming, and response competition measures) are utilized [36]. While students with ecocentric attitudes use rational, emotional, and rationalistic-emotional reasoning more frequently, anthropocentric students primarily use rational reasoning [37]. It is estimated that students' high level of environmental thinking before education impacts their level of environmental thinking, which remains the same after education [38]. Students can develop their critical thinking skills and environmental attitudes using problem-based learning models to solve environmental issues [39]. The more crucial thing a nation can do for the environment is to address any issues that arise and try to solve them [6].

Other research findings indicate that most teachers incorporate environmental education into science, social studies, and value-based instruction. Few also discuss various environmental viewpoints. Teachers do not promote students' development of their own opinions and ideas when discussing various environmental issues [40]. The results showed that high school students had an environment-centered and people-centered attitude towards issues related to sensitive behavior and caring behavior. However, students must develop a human-centered attitude towards energy/product conservation and issues such as waste sorting, throwing waste in recycling bins, and using products with recycled materials in packaging. Everything learned in environmental awareness is applied to life situations [41]. When a problem has an economic component, it is advised to conduct environmental education that supports students' environmental attitudes and motivates them to recycle applications [37].

4. CONCLUSION

This study validated the questionnaire used as a tool to measure the environmental attitude of junior high school students through science learning with an Ethno-STEM approach. At the initial stage, the questionnaire contained 16 statement items. However, after the CFA and EFA verification processes, 11 statements remained. Additionally, the 11 items were categorized into four dimensions according to the factor analysis results. Three items comprised the first dimension, three comprised the second dimension, three comprised the third dimension, and two comprised the fourth dimension. Validated instruments can be recommended for use in science learning with an Ethno-STEM approach. The findings of this study formed the basis for curriculum restructuring to help students deal with global environmental problems. The development of attitude-related scales in different cultural settings is becoming increasingly important. Efforts are needed to study student involvement in environmental protection activities to shape the individual-environment and a more sustainable environmental transformation. This research suggests developing teaching materials and training for teachers in teaching and integrating environmental education in various subjects.

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REFERENCES

[1] J. Osborne, "The 21st century challenge for science education: Assessing scientific reasoning," *Thinking Skills and Creativity*, vol. 10, pp. 265–279, 2013, doi: 10.1016/j.tsc.2013.07.006.

[2] V. Prachagool and P. Nuangchalerm, "Investigating understanding the nature of science," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 8, no. 4, pp. 719–725, 2019, doi: 10.11591/ijere.v8i4.20282.

[3] E. F. Pienaar, D. K. Lew, and K. Wallmo, "Are environmental attitudes influenced by survey context? An investigation of the context dependency of the New Ecological Paradigm (NEP) Scale," *Social Science Research*, vol. 42, no. 6, pp. 1542–1554, 2013, doi: 10.1016/j.ssresearch.2013.07.001.

[4] M. Bøhlerengen and N. Wiium, "Environmental attitudes, behaviors, and responsibility perceptions among Norwegian youth: associations with positive youth development indicators," *Frontiers in Psychology*, vol. 13, 2022, doi: 10.3389/fpsyg.2022.844324.

[5] S. Otto, G. W. Evans, M. J. Moon, and F. G. Kaiser, "The development of children's environmental attitude and behavior," *Global Environmental Change*, vol. 58, no. August 2018, p. 101947, 2019, doi: 10.1016/j.gloenvcha.2019.101947.

[6] H. Mahat, N. Nayan, M. Hashim, Y. Saleh, and S. B. Norkhaidi, "Engagement and commitment in Eco-Campus activities of pre-service teachers: Confirmatory factor analysis," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 11, no. 3, pp. 1318–1329, 2022, doi: 10.11591/ijere.v11i3.22001.

[7] S. Ramadhan, E. Sukma, and V. Indriyani, "Environmental education and disaster mitigation through language learning," in *IOP Conference Series: Earth and Environmental Science*, 2019, vol. 314, no. 1. doi: 10.1088/1755-1315/314/1/012054.

[8] R. Kang and J. Peters, "Dunhuang As A Model For EthnoSTEM Education," *The Dunhuang Grottoes and Global Education: Philosophical, Spiritual, Scientific, and Aesthetics Insights*, pp. 135–160, 2019, doi: 10.1007/978-3-030-13356-6.

[9] S. Sudarmin, W. Sumarni, P. Rr Sri Endang, and S. Sri Susilogati, "Implementing the model of project-based learning: integrated with ETHNO-STEM to develop students' entrepreneurial characters," *Journal of Physics: Conference Series*, vol. 1317, no. 1, 2019, doi: 10.1088/1742-6596/1317/1/012145.

[10] F. Reffiane, Sudarmin, Wiyanto, and S. Saptono, "Developing an Instrument to Assess Students' Problem-Solving Ability on Hybrid Learning Model Using Ethno-STEM Approach through Quest Program," *Pegem Egitim ve Ogretim Dergisi*, vol. 11, no. 4, pp. 1–8, 2021, doi: 10.47750/pegegog.11.04.01.

[11] W. Sumarni and S. Kadarwati, "Ethno-stem project-based learning: Its impact to critical and creative thinking skills," *Jurnal Pendidikan IPA Indonesia*, vol. 9, no. 1, pp. 11–21, 2020, doi: 10.15294/jpii.v9i1.21754.

[12] A. Muttaqiin, M. Murtiani, and Y. Yulkifli, "Is Integrated Science Book with Ethno-STEM Approach Needed by Secondary School Students?" *Journal of Physics: Conference Series*, vol. 1788, no. 1, 2021, doi: 10.1088/1742-6596/1788/1/012048.

[13] Sudarmin, W. Sumarni, S. Mursiti, and S. S. Sumarti, "Students' innovative and creative thinking skill profile in designing chemical batik after experiencing ethnoscience integrated science technology engineering mathematic integrated ethnoscience (ethno-STEM) learnings," *Journal of Physics: Conference Series*, vol. 1567, no. 2, 2020, doi: 10.1088/1742-6596/1567/2/022037.

[14] W. Sumarni, S. Sudarmin, S. S. Sumarti, and S. Kadarwati, "Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach," *Cultural Studies of Science Education*, vol. 17, no. 2, pp. 467–510, 2022, doi: https://doi.org/10.1007/s11422-021-10067-3.

[15] S. N. Izzah, S. Sudarmin, W. Wiyanto, and A. Prasetyo, "Identification of the indigenous science concepts in the batik-manufacturing process to develop STEM integrated ethnoscience learning," *Journal of Physics: Conference Series*, vol. 1567, no. 042032, pp. 1–6, 2020, doi: 10.1088/1742-6596/1567/4/042032.

[16] E. Artvinli and Z. M. Demir, "A Study of Developing an Environmental Attitude Scale for Primary School Students," *Journal of Education in Science, Environment and Health*, vol. 4, no. 1, pp. 32–45, 2018, doi: 10.21891/jeseh.387478.

[17] N. Uzun, K. L. Gilbertson, O. Keles, and I. Ratinen, "Environmental Attitude Scale for Secondary School, High School and Undergraduate Students: Validity and Reliability Study," *Journal of Education in Science Environment and Health*, vol. 5, no. 1, pp. 79–90, 2019, doi: 10.21891/jeseh.491259.

[18] N. Dolenc Orbanić and N. Kovač, "Environmental awareness, attitudes, and behaviour of preservice preschool and primary school teachers," *Journal of Baltic Science Education*, vol. 20, no. 3, pp. 373–388, 2021, doi: 10.33225/jbse/21.20.373.

[19] E. W. Winarni, M. Karpudewan, B. Karyadi, and G. Gumono, "Integrated PjBL-STEM in Scientific Literacy and Environment Attitude for Elementary School," *Asian Journal of Education and Training*, vol. 8, no. 2, 2022, doi: 10.20448/edu.v8i2.3873.

[20] A. Orhan, "Critical Thinking Dispositions as a Predictor for High School Students' Environmental Attitudes," *Journal of Education in Science, Environment and Health*, vol. 8, no. 1, pp. 75–85, 2022, doi: 10.21891/jeseh.1056832.

[21] Sudarmin, S. Mursiti, S. Sarwi, and P. Listiaji, "Secondary metabolite learning model from Taxus sumatrana with ethnoscience integrated inquiry using online system and google form application," *Journal of Physics: Conference Series*, vol. 1918, no. 3, 2021, doi: 10.1088/1742-6596/1918/3/032025.

[22] Sudarmin, W. Sumarni, D. Yulianti, and Zaenuri, "Developing Students' Entrepreneurial Characters through Downstreaming Research on Natural Product Learning with Ethnoscience Integrated Stem," *Journal of Physics: Conference Series*, vol. 1387, no. 1, 2019, doi: 10.1088/1742-6596/1387/1/012085.

[23] S. Sudarmin, C. Kurniawan, N. Puji, Musyarofah, Ariyatun, and I. Nurul, "The Implementation of Chemical Project Learning Model Integrated with Ethno-Stem Approach on Water Treatment Topic Using Kelor (Moringa oleifera) Seed Extract As Bio-Coagulant," *KnE Social Sciences*, vol. 2019, pp. 492–501, 2019, doi: 10.18502/kss.v3i18.4740.

[24] F. Gülhan and F. Şahin, "The effects of science-technology-engineering-math (STEM) integration on 5th grade students' perceptions and attitudes towards these areas," *International Journal of Human Sciences*, vol. 13, no. 1, p. 602, 2016, doi: 10.14687/ijhs.v13i1.3447.

[25] S. N. Izzah, S. Sudarmin, W. Wiyanto, and A. Prasetyo, "The development of science learning document grounded on STEM-approach integrated ethnoscience," *Proceedings of the International Conference on Science and Education and Technology (ISET 2019)*, 2020, vol. 443, pp. 554–558.

[26] T. L. Milfont and J. Duckitt, "The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes," *Journal of Environmental Psychology*, vol. 30, no. 1, p. 80, 2010, doi: 10.1016/j.jenvp.2009.09.001.

[27] K. S. Hollweg, J. R. Taylor, R. W. Bybee, T. J. Marcinkowski, W. C. McBeth, and P. Zoido, *Developing a framework for assessing environmental literacy*. Washington, DC: North American Association for Environmental Education, 2011.

[28] G. Imam and Fuad, *Structural Equation Modelling: Theory, Concepts, and Applications with Lisrel 9.10 Program*. Semarang: Universitas Diponegoro Publishing Agency (in Indonesian), 2014.

[29] N. Ö. Gübeş, H. Keten, and H. S. Köse, "Development of the Scale for Environmental Aesthetic Awareness and investigation of students' environmental aesthetic awareness," *Pegem Egitim ve Ogretim Dergisi*, vol. 10, no. 4, pp. 1066–1100, 2020, doi: 10.14527/pegegog.2020.033.

[30] S. Sharma, *Applied Multivariate Techniques*. New York: John Wiley & Sons, Inc, 1997.
[31] K. G. Jöreskog and D. Sörbom, *LISREL 7: A guide to the program and applications*. SPSS, 1989.
[32] R. Fernandez-Manzanal, L. Rodriguez-Barreiro, and J. Carrasquer, "Evaluation of Environmental Attitudes: Analysis and Results of a Scale Applied to University Students," *Science Education*, vol. 91, pp. 988–1009, 2007, doi: 10.1002/sce.
[33] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, *Multivariate Data Analysis*, 7th ed. Pearson Prentice Hall, 2010.
[34] T. L. Milfont and J. Duckitt, "The structure of environmental attitudes: A first- and second-order confirmatory factor analysis," *Journal of Environmental Psychology*, vol. 24, no. 3, pp. 289–303, 2004, doi: 10.1016/j.jenvp.2004.09.001.
[35] H. Mahat, M. Hashim, N. Nayan, S. Balkhis Norkhaidi, and Y. Saleh, "Development of Environmental Awareness Measurement Instruments Through Education for Sustainable Development," *Proceedings of the 8th UPI-UPSI International Conference 2018 (UPI-UPSI 2018)*, 2019, vol. 239, pp. 73–86, doi: 10.2991/upiupsi-18.2019.13.
[36] T. L. Milfont and C. G. Sibley, "The big five personality traits and environmental engagement: Associations at the individual and societal level," *Journal of Environmental Psychology*, vol. 32, no. 2, pp. 187–195, 2012, doi: 10.1016/j.jenvp.2011.12.006.
[37] N. Atabey and M. S. Topcu, "Middle School Students' Environmental Attitudes and Informal Reasoning Regarding an Environmental Socioscientific Issue," *International Journal of Progressive Education*, vol. 16, no. 5, pp. 90–105, 2020, doi: 10.29329/ijpe.2020.277.6.
[38] L. Özalemdar, "The Effect on Environmental Attitude of the Active Learning Method Applied in Teaching the Biology Topic 'Current Environmental Issues and Human' for 10th Grade Students," *Journal of Turkish Science Education*, vol. 18, no. 2, pp. 276–289, 2021, doi: 10.36681/tused.2021.65.
[39] S. Amin, S. Utaya, S. Bachri, Sumarmi, and S. Susilo, "Effect of problem-based learning on critical thinking skills and environmental attitude," *Journal for the Education of Gifted Young Scientists*, vol. 8, no. 2, 2020, doi: 10.17478/jegys.650344.
[40] E. Marpa, "Navigating Environmental Education Practices to Promote Environmental Awareness and Education," *International Journal on Studies in Education*, vol. 2, no. 1, pp. 45–57, 2020, doi: 10.46328/ijonse.8.
[41] R. Danielraja, "A Study of Environmental Awareness of Students at Higher Secondary Level," *Shanlax International Journal of Education*, vol. 7, no. 3, pp. 6–10, 2019, doi: 10.34293/education.v7i3.480.

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